CROP WATCH

A SMART AGRICULTURE SOLUTION IS IDENTIFYING AREAS AT RISK OF INSECT SWARMING ACTIVITIES USING SATELLITE DATA, CROWDSOURCING AND MACHINE LEARNING. LENA NIETBAUR REPORTS

Insect infestation of farmland constitutes a significant risk to global food security. One insect species that cause a significant amount of damage to food crops, especially in Africa, Asia, Australia and the Middle East, is the locust. The largest swarms of locusts can consume more than 100,000 tonnes of crops each day – enough to feed tens of thousands of people a year.

Grasshoppers on their own do not constitute a problem, but a small amount of overcrowding can trigger swarming, turning a population of solitary grasshoppers into a marauding mob of locusts with a ravenous appetite attacking vegetation and crops. Factors that can cause locusts to swarm are changes in the pattern of soil temperature; weather conditions affected by sea temperature, clouds and wind; and the intensity and duration of the wet and dry seasons.

Advance knowledge of insect infestation activity can enable early, targeted and effective use of pesticides or organic mitigation techniques. This protects farmers against loss of income and earnings due to damaged crops, and reduces the costs of pesticide control and other management activities. Reducing the amount of pesticide also benefits the environment and thus the public.

Foresight Crops is a predictive analysis platform, created by Dr Oluropo Ogundipe and developed by her company GGIS, that uses multi-temporal Earth observation (EO) satellite data combined with crowdsourced information, historical records and weather data to model the forming conditions for insect swarms that are detrimental to crops. It identifies potential breeding grounds and tracking conditions that enable the development of the larva and the trigger for locusts to swarm.

This will provide a platform to enable risk prediction mapping. The more factors that are analysed, the more detailed and reliable the prediction model will be. Thus, data from various data sources are integrated into the platform. These are automatically analysed and formed into prediction models.

EO data is used to model and predict causal factors and triggers for insect swarm activity. The focus is on computing differences in indices such as the normalised difference vegetation index (NDVI) and the soil moisture index (SMI) between peak wet and dry periods, as well as long-term changes at different scales. For the NDVI, EO data from the MODIS 16-day NDVI composite product at 250m resolution are used for historical data analysis. MODIS data ranging back 10 years was downloaded from the USGS website (https://earthexplorer.usgs.gov/) to train the prediction algorithm based on historical parameters. The NDVI is calculated based on the reflections of visible and infra-red light off vegetation. Healthy green leafy vegetation absorbs light in the visible spectrum and reflects a good part of the infra-red light. Unhealthy or sparse vegetation reflects more of the visible light and less of the infra-red. The resulting measure of the vegetation's greenness combined with the SMI provide relevant indices to identify areas of risk for locust swarming.

Soil moisture data will come from the Soil Moisture Active Passive (SMAP) service from NASA's Jet Propulsion Laboratory, providing soil moisture data based on radar data at up to 3km gridding resolution level. In addition, GGIS has tested the use of Arduino-based soil sensors that can be deployed in the field to measure and transmit soil moisture and temperature data.

Based on the analysis of historical satellite data records, the platform can compute and model long-term trends in locust swarming patterns. GGSI has also integrated data provided by the Food and Agriculture

Organization of the United Nations (FAO) Desert Locust Information Service (DLSI) going back to 1985. This data has been gathered in the field concerning the location of desert locust swarms and their stage in their lifecycle. By matching this data with the relating areas of risk identified through the satellite data analysis concerning time and location, the prediction algorithm is trained and the risk prediction models are validated.

For near real-time monitoring of active swarms, additional high-resolution data will be used from the Copernicus Space Component Data Access (CSCDA), especially Sentinel-2 data. Furthermore, weather data from the EUMETSAT service, which provides additional indications of areas of high risk for triggering swarm activity, will be used in the platform.

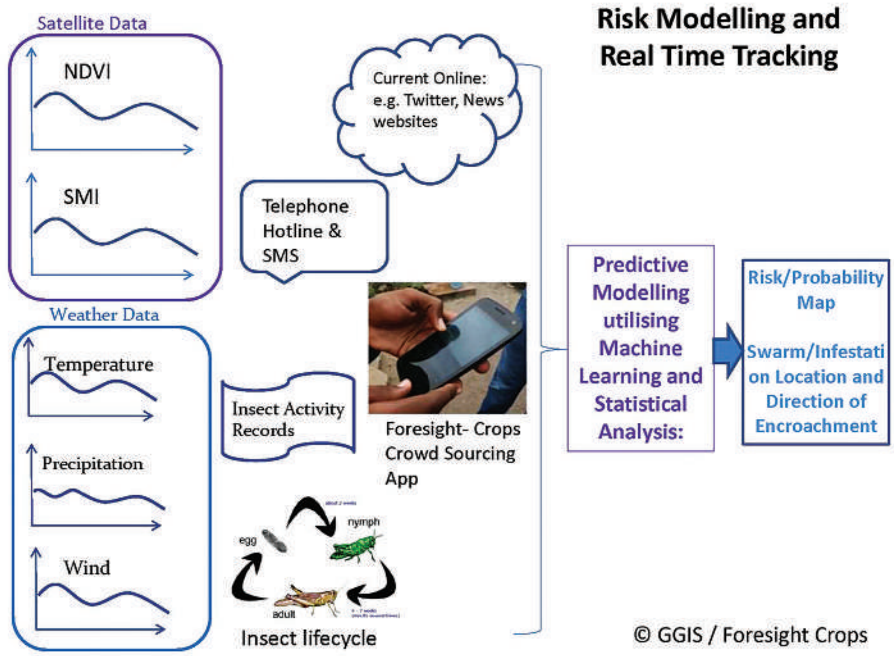
This satellite data is then combined with crowdsourced ground data and local observations from farmers and local communities. Smartphones and tablets are now being used widely, to collect field data in agricultural development projects with remarkable positive results, so GGSI has created a Foresight Crops mobile app, which provides information such as risk prediction mapping to the users and feeds the platform crowdsourced information from farmers and local communities in the form of geo-tagged comments and pictures.

Proof of concept

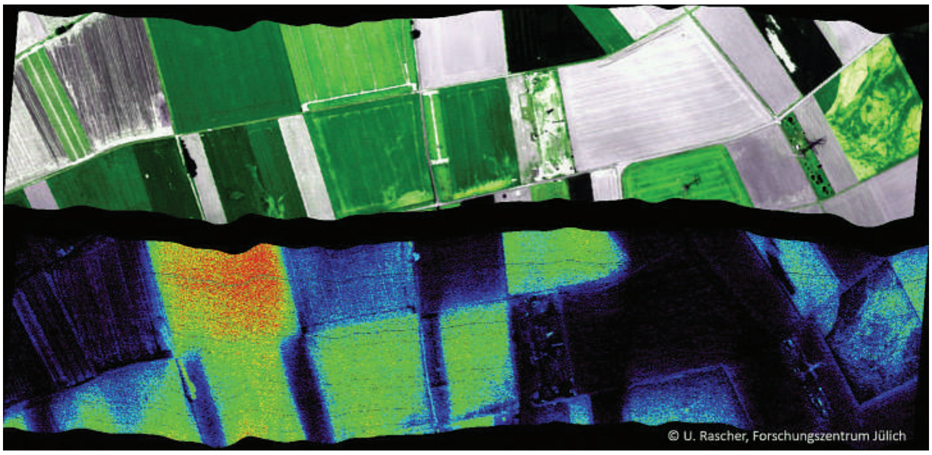
Madagascar has experienced severe locust swarms in recent years. From 2013-16, the FAO and the government of Madagascar started an anti-locust programme, focused on identifying areas of risk and dealing with the locusts using pesticides. This involved ground observations and aerial surveys from helicopters, which requires considerable financial and time resources (US$37m).

The concept of Foresight Crops was first tested in January 2015, based on the FAO Madagascar programme. Oluropo used NASA MODIS data in her initial program to analyse NDVI and SMI data for the peak dry season and the peak wet season from Madagascar for the previous two years. From these datasets, a difference image was computed. The output image showed areas with significant change in NDVI values, which matched up with the risk map developed by FAO. FAO had required 1,025 hours of using three helicopters and one fixed-wing aircraft for its survey, but using EO data, Foresight Crops achieved comparable results within two days.

The software is still being developed and tested, but a strong working prototype that will provide services to consumers by the third quarter of 2017. When in use, it will provide advanced warning and information on the risks of insect swarm or infestation activity occurring at a given location and time. In addition, where there is swarming in progress in a location of interest, this will be tracked and monitored and its probable travel path predicted. It can also be incorporated into a farm's integrated pest management system and will be relevant to a wide range of public and private sector organisations around the world, such as governments, farmers, food companies and the insurance sector.



The Foresight Crops data flow



Fluorescence from different types of vegetation

The food security of 13 million people was threatened in the Madagascar locust crisis

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AZO EARTH OBSERVATION ACTIVITIES

AZO's mission is to boost the user uptake of data provided by the European space programme by aiding visionary entrepreneurs in bringing their innovations to market. For the European Copernicus programme, on behalf of ESA and the European Commission, AZO conducts the Copernicus Masters competition, the Copernicus Accelerator, the Copernicus App Lab, the Space App Camps, and supports several EO start-ups in the ESA Business Incubation Centre Bavaria.

Foresight Crops conducted its first proof of concept an Appathon in line with a Space App Camp and subsequently participated and won the Copernicus Masters University Challenge in October 2015. Encouraged by this success, GGIS was formed to build, develop and exploit the Foresight Crops application.